Status of 3.9-GHz Superconducting RF Cavity Technology at Fermilab*

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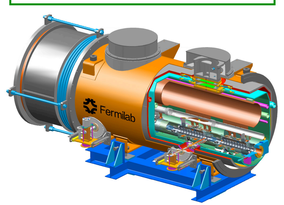
Fermilab is involved in an effort to assemble 3.9 GHz superconducting RF cavities into a four cavity cryomodule for use at the DESY TTF/FLASH facility as a third harmonic structure. The design gradient of these cavities is 14 MV/m. This effort involves design, fabrication, intermediate testing, assembly, and eventual delivery of the cryomodule. We report on all facets of this enterprise from design through future plans. Included will be test results of single 9-cell cavities, lessons learned, and current status.

Parameters

Number of Cavities	4
Active Length	0.346 m
Gradient	14 MV/m
Phase	-179°
R/Q	750
E_{peak}/E_{acc}	2.26
B_{peak} (E_{acc} = 14 MV/m)	68 mT
Q_{ext}	9.5 X 10^5
BBU Limit for HOM, Q	< 1 X 10^5
Total Energy	20 MeV
Beam Current	9 mA
Forward Power	11.5 kW
Coupler Power	45 kW



Cut-away view of 4-cavity Cryomodule

INTRODUCTION

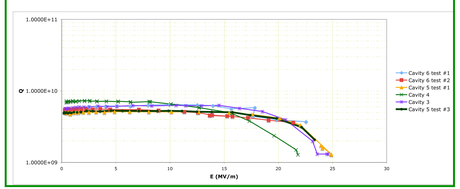
Fermilab has entered into an agreement with DESY to provide a cryomodule containing 4-3.9 GHz superconducting RF cavities to be placed in TTF/FLASH. These cavities are TM010 structures designed to linearize the accelerating gradient of the 1.3 GHz accelerating cavities in this accelerator, thus providing improved longitudinal emittance. The required operating gradient is 14 MV/m.

As a byproduct, another goal of this project is to develop SCRF infrastructure at Fermilab by designing and assembling the necessary components including:

- Cryomodule for 4 cavities
- 4 (+2 spare) dressed cavities with couplers
- Tuners, magnetic shielding, assembly tooling
- Surface processing infrastructure (BCP, HT, HPWR)
- Apparatus and infrastructure for vertically testing single undressed cavities
- Horizontal test cryostat and testing infrastructure for individual dressed cavities including main input coupler
- Cavity string and cryostat assembly infrastructure
- Shipping equipment for cryomodule transport to DESY.

With the design effort virtually complete, effort has turned towards fabrication and testing. It is intended that this work will be completed during late 2007 and the cryomodule delivered to DESY early in 2008.

Cavity Performance Test Results



Cavity Fabrication & Testing Status

Cavity	Assembled by	Completion Date	Test Results
#1: 2-leg HOM	Fermilab	January 2006	Never tested - HOM membrane break during cleaning
#2: 2-leg HOM	Fermilab	February 2006	12 MV/m limited by HOM heating - fractured Formteils
#3: 2-leg HOM, trimmed after initial tests	Fermilab JLab	August 2006	24 MV/m achieved after HOM trimming Q_0 = 5 X 10^9
#4: 2-leg trimmed HOM	Fermilab JLab	March 2007	21 MV/m Q_0 = 8.1 X 10^9
#5: 2-leg trimmed HOM	Fermilab JLab	May 2007	25 MV/m Q_0 = 5.1 X 10^9
#6: 2-leg trimmed HOM	Fermilab JLab	May 2007	22 MV/m Q_0 = 6.4 X 10^9
#7: single-post HOM	Fermilab JLab DESY	In fabrication, expected October 2007	n/a
#8: single-post HOM	Fermilab DESY	In fabrication, expected September 2007	n/a first test expected late October

'Bare' 3.9 GHz Cavity

3.9 GHz Cavity being readied for Vertical test

SUMMARY

Fermilab has embarked on its first significant foray into SCRF technology with the fabrication of a 3.9 GHz cavity string for use in DESY's TTF/FLASH facility. Six cavities have been assembled and five have gone through vertical testing. Four have now achieved the necessary design parameters and have operated at gradients of at least 21 MV/m with acceptable Q_{ext}. Two more cavities will shortly undergo the processing and then the first phase of testing. Most major components are now in hand or are due in the near future. Critical steps remain: welding into helium vessels, horizontal testing, assembly into a 4-cavity string, final assembly, and shipping to DESY. The expectation is to test the module in the DESY Module Test Facility in spring of 2008.

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